Cosmology Glossary

Distance
Astrophysical distances are measured in parsecs (3.12 light years), defined as the distance subtended by an angle of 1 arcsecond with a baseline of 1 AU (astronomical unit, the earth's orbital radius).
1 pc = 3.12 x 10^18 cm

Cosmological Distance:
"True" distance to astrophysical objects depends on

1. Relativistic Redshift: z
2. Hubble Constant: H_0
3. Mass Density: Ω_M
4. Energy Density: Ω_{DE}
5. Curvature of Spacetime: k

Magnitudes
Observed brightness B is $B = L / 4pD^2$
where L is the intrinsic brightness and D is the distance to the source
Magnitude is the unit of apparent brightness
$m = -2.5 \log B$
$= -2.5 \log L / 4\pi D^2$
The absolute magnitude of a source is the apparent magnitude it would have at a distance of 10pc:
$M = -2.5 \log L + 5 + \text{constant}$

Cosmological Redshift :
This is basically the Doppler effect, where the frequency or wavelength shift of the emitted radiation is proportional to the relative velocity between the source and the detector -- i.e. approaching or receding. Cosmologically, the relative velocity is due to the expansion of space-time, not to the motion of the sources. Mathematically the redshift z is defined:

$$z = (8_{obs} - 8_{em}) / 8_{em} = v_{rec} / c$$
$$z =)8/8$$

Relativistic Redshift
At large values of recession velocity, i.e. when z > 0.1, have to take into account relativistic effects. Then the redshift becomes:

$$z = \sqrt{\frac{c + v}{c - v}} - 1$$

$$\frac{v_{true}}{c} = \frac{(z + 1)^2 - 1}{(z + 1)^2 + 1}$$

Hubble Constant: H_0

$$v = H_0 D$$

H_0 is the expansion rate of the universe at a given time. D is the distance to a source, and v is the velocity of recession. The current value of the expansion parameter is

$$H_0 = 67 \text{ km/s/Mpc}$$

Cosmological Constant: Λ
Einstein's "fudge factor", considered to be energy of the vaccuum. It has negative pressure, and its equation of state parameter w = -1 (see definition below).

Critical Density: Δc
when curvature k=0, and the cosmological constant 7=0, then the critical density is

$$\Delta c = 3H^2/8B\,G$$

Mass Density ratio: Σ_M
Σ_M is the ratio of the measured mass density to the critical density:

$$\Sigma_M = \Delta_M / \Delta_c$$

The total matter density is sum of baryonic and dark matter $\Sigma_M = \Sigma_B + \Sigma_{DM}$. Matter density decreases with time as the universe expands.

Energy – Mass Density ratio: Σ_T
The total energy–mass density ratio is the sum of mass and energy density:

$$\Sigma_T = \Sigma_M + \Sigma_{DE}$$

where $\Sigma_{DE} = 37/H^2$, (vacuum) energy density. A flat universe, k=0, has $\Sigma_T = 1$

Equation of State of the Universe

$$p = w\rho \rightarrow \rho \propto R^{-3(1+w)}$$

where *w* can vary with time (or equivalently with redshift *z*). The equation of state is the relationship between pressure p and density Δ of stuff (matter and/or energy).